

Phone: STerling 3-4100

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue

Washington 6, D. C.

January 20, 1967

Dr. John T. Holloway, Acting Director
Office of Grants and Research Contracts
Office of Space Science and Application
National Aeronautics and Space Administration
Washington, D.C. 20546

Re: NsG 35-60

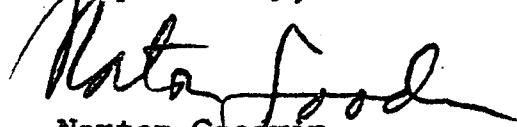
Dear Dr. Holloway:

Our last regular report was forwarded to you under date of October 20, 1966, covering the period 1 July through 30 September, 1966.

Enclosed please find Summary and Report of Activities for the fourth quarter period, 1 October to 31 December, 1966.

A financial statement in the prescribed NASA Form 1030-1031 for the same period is going forward by separate mail.

Respectfully,


Norton Goodwin
Program Director

Enclosures:

1. Summary and Report
2. EXHIBITS A through L.



INDEPENDENT TRACKING COORDINATION PROGRAM

SUMMARY OF PROGRESS AND REPORT OF ACTIVITIES - NSG 35-60 4th Q 1966

I. TRACKING AND DATA ACQUISITION

- A. During the period, a number of observations have been received from independent tracking sources overseas and forwarded to Goddard Space Flight Center. (See EXHIBIT A attached for itemized list of 679 observations).
- B. During the period, 2,638 sets of current gear ratio elements derived by NASA's Goddard Space Flight Center from NORAD data were included in ITCP biweekly airmail orbital element announcements. (See EXHIBIT B for itemized listing by satellite. Copies of EXHIBITS C, D, E, F, G, H, I - biweekly announcements are also attached.)

II. ADDITIONS TO INDEX

Additions to the Index giving Catalog Numbers and Popular Names corresponding to IDENT Designations of Recently Unclassified Artificial Earth Satellites were issued in conjunction with biweekly orbital element announcements, on the following dates:

| | | |
|------------------|---|-----------|
| October 3, 1966 | - | EXHIBIT C |
| October 17, 1966 | - | D |
| November 14, '66 | - | F |
| November 28, '66 | - | G |
| December 19, '66 | - | H |
| December 31, '66 | - | I |

III. LIST OF RADIO-TRANSMITTING SATELLITES

A list of satellites believed to be transmitting as of December 15, 1966 was published in conjunction with the orbital element announcement mailed to all addressees December 19, 1966. (EXHIBIT J) The listing is ordered by IDENT designations and includes the Popular Name and Catalog Numbers, as well as frequency data on the various satellites. Channels operating on COMMAND only are listed with the letter, C, in the place of the decimal point that would appear in the frequency field.

IV. BULLETIN ON DAY NUMBERS FOR RECORDING CHRONOLOGICAL DATA

The subject bulletin explains the advantages in using day numbers in a continuous chronological era for specification of epoch, instead of calendar days, months, and years. Savings in data processing, calculations, and communications effort are

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emphasized. The relation between Universal Time (U.T.) and the polar angle formed by the Greenwich Meridian and the geocentric direction of the earth's mean shadow center is explained.

Computer subroutines, JAYDAY and CALDAY are given. Subroutine JAYDAY gives the Modified Julian Day number corresponding to the Gregorian calendar day, month and year of the 20th and 21st centuries. Subroutine CALDAY gives Gregorian day, month, and year corresponding to the Modified Julian Date.

Two tabulations to facilitate hand conversion are included. A tabulation of Modified Julian Date corresponding to the zeroth day of each month from January 1951 through December 1999 is included. Use of the tabulation for finding Modified Julian Date from calendar year, month and day is explained, as is use of the tabulation for finding the Modified Julian Date giving Gregorian year, month and day.

The days of the week are shown to be separate and distinct and not a proper part of the calendar. A method for determining week day from Modified Julian Day number is suggested.

A tabulation of Modified Julian Day Number for each day of the week from January 1, 1966 through December 31, 1968 is given. (EXHIBIT K)

V. POCKET CALENDAR

A pocket calendar (EXHIBIT L) giving Modified Julian Day number for each day of the year, from January 1, 1967 to December 31, 1967 was included with the bulletin of December 30, 1966. These cards facilitate interpretation of NORAD and Gear Ratio Elements supplied by ITCP.

VI. COMPUTER PROGRAMS FOR LOCAL PREDICTIONS TO NEWS MEDIA

One of the important projects in which the ITCP is currently engaged is the development of efficient computer programs whereby news media can generate local predictions for bright evening passes of artificial earth satellites. Programs for generating printouts edited and formatted for direct photoreproduction by the newspapers for which it was prepared is a specific objective.

Programming approaches for local computation of local news media consumption, as well as program approaches for centralized computation of local predictions for a number of localities are under study. Substantial progress was made during the quarter in adapting these programs to local news media requirements.

VII. SUPPORT OF TRACKING ACTIVITIES AT MORE THAN ONE LOCATION

Efficient computer utilization for the support of the tracking activities of two or more observers at different locations requires the development of a system of related computer programs capable of generating observation schedules and prediction data from available elements, and of analyzing and improving orbital elements on the basis of reliable data from a number of observers. A great deal of unnecessary computer effort can be eliminated by making use of calculated values in which a number of stations may share. For example, earth shadow calculations, twilight calculations, and moon position calculations affecting optical observation can be distributed over a large number of observers in a fairly broad latitude zone. For maximum effectiveness, such a program requires substantial core storage capacity. A program along these lines has been developed for a computer of the IBM System 360/60 type. A listing of the program and writeup on its use in coordinating observer activity between independent observers may be ready for publication during the next quarter. The subroutines of the program are useful in single-station satellite observation and tracking activities, as well.

VIII. INQUIRIES RECEIVED RE: TRACKING

A marked increase in the number of inquiries on tracking and satellite acquisition from students has been noted. Over twenty-five kits, including 8 sent to addressees overseas were distributed during the period. The kits mailed included the following bulletins and graphic data:

Wulff STEREOGRAPHIC Net
Zenith Distance Finder
Chart for Determining CG/CP (ITCP 2-66)
Bulletin of 3/29/66 - SCHEDULING TIMES OF ORBIT APPROACH
Bulletin of 9/30/65 - STANDARD BRIGHTNESS TABLES
Bulletin of 12/30/65 - EPOCH SPECIFICATION (now revised)
List of Radio-Transmitting Satellites (to radio observers)
Bulletin of 9/29/66 - PRACTICAL ARITHMETIC
Bulletin of 9/30/66 - GRAPHIC PREDICTION OF LOCAL CULMINATIONS; includes ITCP Chart 6-66
Tables of Sines, Cosines and Tangents for Every Tenth Microturn
Rationalized General Catalog of 33,342 Stars

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IX. ANNOUNCEMENTS**Summary of Current Gear Ratio Elements Issued.**

| <u>Date</u> | <u>No. Dist.</u> | <u>No. Satellites</u> | |
|-------------|------------------|-----------------------|---------------------------------------|
| 39401.9 | 490 | 179 | (See EXHIBIT <u>C</u> - Oct. 3, 1966) |
| 39415.9 | 486 | 243 | (" " <u>D</u> - Oct. 17, 1966) |
| 39429.9 | 486 | 243 | (" " <u>E</u> - Oct. 31, 1966) |
| 39443.9 | 472 | 254 | (" " <u>F</u> - Nov. 14, 1966) |
| 39457.9 | 473 | 255 | (" " <u>G</u> - Nov. 28, 1966) |
| 39471.9 | 472 | 242 | (" " <u>H</u> - Dec. 12, 1966) |
| 39485.9 | 536 | 253 | (" " <u>I</u> - Dec. 26, 1966) |

EXHIBITS ATTACHED TO THIS REPORT

- A - List of independent tracking observations received from sources overseas.
- B - List of satellites and number of gear ratio element sets published on each satellite during the period.
- C, D, E, F, G, H, I - Biweekly Airmail Orbital Element Announcements published during the period.
- J - Up-dated List of Radio-Transmitting Satellites as of December 15, 1966.
- K - ITCP Bulletin dated December 30, 1966 - Day Numbers for Recording Chronological Date
- L - Pocket Calendar of Modified Julian Day Numbers for 1967.

EXHIBIT A

NsG 35-60

The following observations have been received by the Independent Tracking Coordination Program from independent observers overseas:

| <u>NCAT</u> | <u>No.</u> | <u>NCAT</u> | <u>No.</u> |
|-------------|------------|-------------|------------------|
| 0045 | 3 | 1520 | 1 |
| 0049 | 11 | 1537 | 39 |
| 0059 | 1 | 1575 | 1 |
| 0163 | 4 | 1577 | 2 |
| 0271 | 1 | 1620 | 2 |
| 0397 | 1 | 1625 | 1 |
| 0444 | 3 | 1726 | 1 |
| 0446 | 6 | 1738 | 1 |
| 0520 | 2 | 1779 | 2 |
| 0564 | 1 | 1804 | 3 |
| 0613 | 2 | 1806 | 1 |
| 0622 | 4 | 1843 | 1 |
| 0624 | 4 | 1864 | 1 |
| 0671 | 2 | 1869 | 1 |
| 0683 | 14 | 1997 | 2 |
| 0684 | 1 | 2168 | 1 |
| 0714 | 17 | 2169 | 2 |
| 0715 | 39 | 2172 | 1 |
| 0727 | 1 | 2253 | 165 |
| 0740 | 146 | 2255 | 13 |
| 0748 | 1 | 2296 | 1 |
| 0751 | 1 | 2338 | 2 |
| 0876 | 10 | 2397 | 3 |
| 0922 | 1 | 2403 | 18 |
| 0924 | 4 | 2418 | 1 |
| 0931 | 10 | 2431 | 1 |
| 0941 | 1 | 2437 | 1 |
| 0953 | 1 | 2481 | 15 |
| 1092 | 54 | | |
| 1097 | 1 | | |
| 1098 | 2 | Unknown | 7 |
| 1271 | 1 | | |
| 1310 | 1 | | |
| 1355 | 1 | | |
| 1420 | 2 | | |
| 1422 | 1 | | |
| 1447 | 3 | | |
| 1448 | 3 | | |
| 1510 | 3 | | |
| 1515 | 3 | | |
| | | | 679 Observations |
| | | | on 68 satellites |

1/20/67

EXHIBIT B

Recapitulation of Current Gear Ratio Elements published in
Biweekly Airmail Announcements (See Exhibits C through I)

| <u>NCAT</u> | <u>No.</u> |
|-------------|------------|-------------|------------|-------------|------------|-------------|------------|-------------|------------|
| 0004 | 10 | 0255 | 7 | 0602 | 2 | 0801 | 3 | 1098 | 9 |
| 0005 | 3 | 0257 | 7 | 0603 | 2 | 0812 | 2 | 1207 | 1 |
| 0011 | 2 | 0271 | 1 | 0604 | 3 | 0813 | 3 | 1208 | 2 |
| 0012 | 4 | 0273 | 4 | 0605 | 6 | 0824 | 8 | 1228 | 25 |
| 0016 | 1 | 0274 | 2 | 0608 | 2 | 0829 | 5 | 1244 | 2 |
| 0020 | 4 | 0285 | 10 | 0612 | 8 | 0830 | 8 | 1245 | 2 |
| 0022 | 5 | 0288 | 9 | 0613 | 7 | 0851 | 14 | 1248 | 21 |
| 0023 | 5 | 0309 | 5 | 0614 | 9 | 0869 | 2 | 1250 | 21 |
| 0028 | 1 | 0311 | 4 | 0622 | 2 | 0870 | 2 | 1267 | 17 |
| 0029 | 4 | 0340 | 1 | 0624 | 12 | 0871 | 2 | 1268 | 16 |
| 0031 | 8 | 0341 | 3 | 0630 | 2 | 0872 | 10 | 1269 | 17 |
| 0043 | 5 | 0369 | 2 | 0635 | 2 | 0876 | 1 | 1270 | - |
| 0045 | 6 | 0370 | 5 | 0634 | 1 | 0877 | 1 | 1271 | 2 |
| 0046 | 6 | 0378 | 6 | 0669 | 1 | 0878 | 6 | 1272 | 1 |
| 0047 | 3 | 0388 | 2 | 0670 | 2 | 0897 | 2 | 1273 | 9 |
| 0049 | 9 | 0397 | 1 | 0671 | 1 | 0899 | 4 | 1291 | 3 |
| 0050 | 2 | 0398 | 4 | 0683 | 6 | 0900 | 5 | 1292 | 3 |
| 0053 | 2 | 0424 | 5 | 0694 | 7 | 0902 | 5 | 1293 | 7 |
| 0058 | 6 | 0426 | 2 | 0703 | 4 | 0907 | 2 | 1310 | 3 |
| 0059 | 3 | 0444 | 24 | 0704 | 4 | 0913 | - | 1314 | 1 |
| 0060 | 7 | 0445 | - | 0705 | 5 | 0922 | 8 | 1315 | 2 |
| 0062 | 7 | 0446 | 2 | 0714 | 8 | 0924 | 6 | 1316 | 7 |
| 0063 | 2 | 0447 | 3 | 0716 | 3 | 0925 | 10 | 1317 | - |
| 0064 | 3 | 0503 | 3 | 0717 | 2 | 0931 | 16 | 1324 | 15 |
| 0070 | 6 | 0504 | 16 | 0721 | 3 | 0932 | 5 | 1328 | 2 |
| 0079 | 6 | 0506 | 6 | 0727 | 2 | 0933 | 3 | 1329 | 9 |
| 0082 | 1 | 0509 | 4 | 0728 | 1 | 0959 | 8 | 1359 | 2 |
| 0099 | 6 | 0515 | 3 | 0729 | 1 | 0965 | 7 | 1361 | 2 |
| 0107 | 6 | 0519 | 3 | 0730 | 2 | 0973 | 9 | 1377 | 4 |
| 0116 | 1 | 0527 | 9 | 0731 | 1 | 0978 | 2 | 1378 | 3 |
| 0117 | 2 | 0533 | 7 | 0733 | 2 | 0983 | - | 1381 | 8 |
| 0162 | 1 | 0534 | 7 | 0734 | 2 | 0987 | 4 | 1385 | 3 |
| 0163 | 2 | 0535 | 9 | 0735 | 2 | 1000 | 2 | 1420 | 3 |
| 0165 | 2 | 0536 | 5 | 0737 | 3 | 1001 | 3 | 1422 | 8 |
| 0192 | 1 | 0564 | 20 | 0738 | 2 | 1002 | 3 | 1425 | 2 |
| 0202 | 6 | 0573 | 3 | 0740 | 13 | 1085 | 7 | 1430 | 1 |
| 0204 | 3 | 0574 | 5 | 0746 | 5 | 1088 | 5 | 1431 | 20 |
| 0205 | 2 | 0575 | 4 | 0748 | 9 | 1089 | 20 | 1441 | 10 |
| 0226 | 3 | 0579 | 5 | 0759 | 9 | 1090 | 16 | 1442 | 5 |
| 0227 | 2 | 0589 | 1 | 0771 | 14 | 1091 | 18 | 1443 | 5 |
| | | 0594 | 5 | 0775 | 13 | 1097 | 5 | 1444 | 6 |

EXHIBIT B - Recap of Elements - Page 2

| <u>NCAT</u> | <u>No.</u> | <u>NCAT</u> | <u>No.</u> |
|-------------|------------|-------------|------------|-------------|------------|-------------|------------|-------------|------------|----------------|------------|
| 1445 | 5 | 1842 | 13 | 2200 | 27 | 2418 | 4 | 2515 | 3 | 2588 | 2 |
| 1447 | 10 | 1843 | 6 | 2201 | 6 | 2419 | 4 | 2516 | 2 | 2589 | 2 |
| 1448 | 6 | 1844 | 5 | 2202 | 23 | 2420 | 5 | 2517 | 8 | 2590 | 1 |
| 1467 | 9 | 1864 | 1 | 2205 | 22 | 2422 | 4 | 2518 | 3 | 2591 | 1 |
| 1468 | 9 | 1865 | 3 | 2206 | 4 | 2424 | 21 | 2519 | 8 | 2592 | 1 |
| 1472 | 7 | 1868 | 5 | 2207 | 3 | 2427 | 13 | 2520 | 1 | 2593 | 1 |
| 1502 | 1 | 1869 | 4 | 2208 | - | 2428 | 17 | 2521 | 4 | 2594 | 1 |
| 1504 | 2 | 1870 | - | 2215 | 3 | 2429 | 1 | 2522 | 3 | 2595 | 1 |
| 1506 | 2 | 1949 | 24 | 2216 | 3 | 2431 | 4 | 2523 | 7 | 2596 | 1 |
| 1508 | 2 | 1952 | 5 | 2217 | 5 | 2432 | 4 | 2524 | 10 | 2597 | 1 |
| 1510 | 3 | 1967 | 9 | 2218 | 3 | 2433 | 8 | 2525 | 9 | 2599 | 1 |
| 1511 | 3 | 1982 | 3 | 2219 | 4 | 2435 | 0 | 2526 | 8 | 2600 | 1 |
| 1512 | 3 | 1983 | 3 | 2220 | 4 | 2436 | 7 | 2527 | 9 | 2601 | 1 |
| 1514 | 1 | 1997 | 11 | 2221 | 5 | 2437 | 35 | 2528 | 6 | 2602 | 1 |
| 1515 | 4 | 2002 | 25 | 2253 | 20 | 2438 | 18 | 2529 | 2 | 2603 | 1 |
| 1570 | 3 | 2003 | 26 | 2254 | 7 | 2439 | 2 | 2530 | 3 | 2604 | 1 |
| 1571 | 3 | 2016 | 5 | 2255 | 3 | 2440 | 12 | 2531 | 2 | 2605 | 1 |
| 1572 | 2 | 2017 | 5 | 2257 | 5 | 2441 | 24 | 2532 | 3 | 2606 | 2 |
| 1573 | 3 | 2091 | 2 | 2259 | 1 | 2481 | 8 | 2533 | 5 | 2608 | 1 |
| 1574 | 2 | 2096 | 2 | 2295 | 23 | 2482 | 5 | 2536 | 5 | 2609 | 2 |
| 1575 | 4 | 2104 | 10 | 2296 | 8 | 2484 | 30 | 2537 | 5 | 2610 | 1 |
| 1580 | 4 | 2119 | 4 | 2301 | 1 | 2485 | 7 | 2538 | 1 | 2611 | 1 |
| 1584 | 2 | 2120 | 2 | 2324 | 14 | 2486 | 4 | 2539 | 1 | 2612 | 1 |
| 1585 | 2 | 2121 | 4 | 2327 | 6 | 2487 | 6 | 2540 | 1 | 2613 | 1 |
| 1586 | 2 | 2122 | 3 | 2328 | 3 | 2488 | 1 | 2541 | 2 | 2614 | 1 |
| 1587 | 2 | 2123 | 3 | 2348 | 12 | 2489 | 7 | 2542 | 1 | 2615 | 1 |
| 1588 | 1 | 2124 | 2 | 2381 | 1 | 2490 | 8 | 2543 | 6 | 2616 | 1 |
| 1589 | 2 | 2125 | 2 | 2383 | 17 | 2491 | 2 | 2544 | 4 | 2617 | 1 |
| 1604 | 1 | 2129 | 3 | 2384 | 9 | 2492 | 7 | 2545 | 2 | 2618 | 1 |
| 1613 | 28 | 2142 | 5 | 2385 | 5 | 2493 | 7 | 2547 | 1 | 2619 | 1 |
| 1620 | 10 | 2144 | 3 | 2386 | 4 | 2494 | 1 | 2548 | 2 | 2620 | 1 |
| 1621 | 1 | 2150 | 9 | 2387 | 2 | 2495 | 1 | 2550 | 2 | 2622 | 1 |
| 1624 | 9 | 2151 | 1 | 2388 | 12 | 2496 | 4 | 2555 | 3 | 2623 | 1 |
| 1625 | 6 | 2152 | 19 | 2389 | 8 | 2497 | 4 | 2565 | 4 | 2624 | 1 |
| 1726 | 5 | 2168 | 4 | 2390 | 6 | 2498 | 6 | 2566 | 1 | 2625 | 1 |
| 1738 | 6 | 2169 | 6 | 2397 | 7 | 2499 | 2 | 2567 | 1 | 2627 | 1 |
| 1739 | 9 | 2172 | 8 | 2399 | 18 | 2500 | 4 | 2568 | 4 | 2628 | 1 |
| 1777 | 26 | 2173 | 2 | 2401 | 3 | 2501 | 5 | 2569 | 3 | 2629 | 1 |
| 1778 | 4 | 2174 | 2 | 2403 | 14 | 2502 | 6 | 2570 | 1 | 2630 | 1 |
| 1779 | 23 | 2176 | 9 | 2404 | 7 | 2503 | 14 | 2571 | 1 | 2631 | 1 |
| 1781 | - | 2180 | 4 | 2405 | 17 | 2504 | 7 | 2572 | 3 | 2632 | 1 |
| 1804 | 7 | 2182 | 35 | 2411 | 6 | 2505 | 10 | 2573 | 4 | 2633 | 1 |
| 1806 | 8 | 2183 | 8 | 2412 | 4 | 2509 | 2 | 2574 | 2 | | |
| 1807 | 4 | 2184 | 19 | 2413 | 2 | 2510 | 2 | 2577 | 1 | | |
| 1814 | 2 | 2185 | - | 2414 | 19 | 2511 | 1 | 2578 | 1 | | |
| 1815 | 2 | 2186 | 1 | 2417 | 12 | 2514 | 2 | 2580 | 1 | TOTAL | |
| | | | | | | | | | | 467 satellites | |

NCAT #

No.

GR2

E

AJNE ANRP APRM1 IPRN

ANRP

CG

ANGR

CG

APRM1

IPRN

GR1

CG

ADDITIONS TO INDEX

Catalog Numbers and Popular Names Corresponding
to IDENT Designations of Recent Unclassified Earth Satellites

| IDENT | NAME | NCAT | IDENT | NAME | NCAT |
|-----------|------------|-----------|------------|-------------|-------|
| 1966 74B | 02397 | 1966 95B | ROCKET BOD | 02513 | |
| 1966 75B | ROCKET BOD | 02399 | 1966 96A | INTEL SAT 2 | 02514 |
| 1966 75C | 02402 | 1966 96B | ROCKET BOD | 02515 | |
| 1966 75D | 02405 | 1966 97A | OV3-2 | 02517 | |
| 1966 75E | 02572 | 1966 97B | 02519 | | |
| 1966 76A | 02401 | 1966 99A | TITAL 3C 9 | 02524 | |
| 1966 76B | ROCKET BOD | 02413 | 1966 99B | OV4-1R | 02526 |
| 1966 76C | 02580 | 1966 99D | OV4-1T | 02528 | |
| 1966 77A | 02403 | 1966 101G | 02543 | | |
| 1966 77B | EGRS VII | 02411 | 1966 103A | GEMINI TV | 02565 |
| 1966 77C | ERD-15 | 02412 | 1966 104F | | |
| 1966 80A | GEMINI TV | 02414 | 1966 104G | 02589 | |
| 1966 82A | 02601 | 1966 107A | COSMOS 133 | 02601 | |
| 1966 82B | 02422 | 1966 108A | 02604 | | |
| 1966 83B | 02420 | 1966 108B | 02606 | | |
| 1966 84B | 02426 | 1966 109A | 02610 | | |
| 1966 87A | ESSA-3 | 02435 | 1966 111A | 02611 | |
| 1966 87B | 02436 | 1966 111B | 02612 | | |
| 1966 87C | 02518 | 1966 112A | 02612 | | |
| 1966 88B | 02438 | 1966 112B | 02612 | | |
| 1966 88E | 02441 | 1966 113A | 02618 | | |
| 1966 88AY | 02484 | 1966 114A | 02619 | | |
| 1966 89A | 02481 | 1966 115A | 02624 | | |
| 1966 89B | EGRS VIII | 02520 | 1966 115B | 02625 | |
| 1966 92A | MOLNIYA 4 | 02501 | | | |

LIST OF SATELLITES BELIEVED TO BE TRANSMITTING AS OF JNL = 39474.0 (Dec. 15, 1966)
 (Channels operating on COMMAND only are listed with letter C in place of the decimal point.)

| IDENT | | NAME | NCAT | MC/S |
|-------|------|-------------|--|---|
| 1961 | 15A | OMICRON 1 | TRANSIT 4A | 00116 54C 324C 150C |
| 1962 | 15A | OMICRON 1 | ARIEL 1 | 00285 136.405 |
| 1962 | 49A | B ALPHA 1 | ALOUETTE | 00424 136C591 136C078 |
| 1962 | 60A | B MU 1 | ANNA 1B | 00446 162C 324C |
| 1962 | 68A | B UPSILON 1 | RELAY 1 | 00503 136C140 136C621 |
| 1963 | 22A | | TRANSIT A25 | 00594 150C 400C |
| 1963 | 24A | | TIROS 7 | 00604 136C233 136C924 |
| 1963 | 31A | | SYNCOM 2 | 00634 136C467 1814C069 1815C794 1820C18 |
| 1963 | 38C | | NONE | 00671 136C653 162C324 |
| 1963 | 49B | | NONE | 00704 150C 400C |
| 1963 | 54A | | TIROS 8 | 00716 136C231 136C924 |
| 1964 | 01C | | EGRS | 00729 136.805 |
| 1964 | 01D | | SOLAR RAD | 00730 136.886 |
| 1964 | 03A | | RELAY A16 | 00737 136C620 136.142 |
| 1964 | 04A | | ECHO 2 | 00740 136.019 136.170 |
| 1964 | 06A | | ELEKTRON 1 | 00746 20C005 30C008 |
| 1964 | 06B | | ELEKTRON 2 | 00748 19C430 19C540 90C225 |
| 1964 | 15A | | ARIEL 2 | 00771 136.557 |
| 1964 | 19B | | POLYOT 2 | 00784 19.895 |
| 1964 | 26A | | NONE | 00801 150C 400C |
| 1964 | 47A | | SYNCOM 3 | 00858 136C470 1820C177 1815C794 1814C93 |
| 1964 | 51A | | EXPLORER 20 | 00870 136C326 136C350 136C680 |
| 1964 | 53A | | COSMOS 44 | 00876 90C023 |
| 1964 | 54A | | OGO I | 00879 136C200 400C250 400C850 |
| 1964 | 60A | | EXPLORER 21 | 00889 136C147 |
| 1964 | 64A | | EXPLORER 22 | 00899 136C171 162C 324C 20C 40C 360C |
| 1964 | 74A | | EXPLORER 23 | 00924 136C078 136C861 |
| 1964 | 76A | | EXPLORER 24 | 00931 136.709 |
| 1964 | 76B | | EXPLORER 25 | 00932 136C292 136C860 |
| 1964 | 83C | | NONE | 00959 136.650 162C324 |
| 1964 | 86A | | EXPLORER 26 | 00963 136.273 |
| 1964 | 83D | | NONE | 00965 150C 400C |
| 1965 | 04A | | TIROS 9 | 00978 136C234 136C198 |
| 1965 | 07A | | ORB.SOL.OBS.2 | 00987 136.713 |
| 1965 | 09A | | PEGASUS 1 | 01085 136C410 136C890 |
| 1965 | 16E | | EGRS 3 | 01208 136.840 |
| 1965 | 16D | | SOL RAD | 01291 136.800 |
| 1965 | 16C | | GRAV GRAD 3 | 01292 136.766 |
| 1965 | 32A | | BEACON | 01328 136C740 162C 324C 20C 40C 360C |
| 1965 | 39A | | PEGASUS 8 | 01381 136C410 136C889 |
| 1965 | 42A | | IMP C | 01388 136.125 |
| 1965 | 51A | | TIROS 10 | 01430 136C232 136C924 |
| 1965 | 58C | | ORS 3 | 01460 136.768 |
| 1965 | 60A | | PEGASUS C | 01467 136C410 136C590 |
| 1965 | 63B | | ROCKET BODY | 01506 136.840 |
| 1965 | 81A | | OGO C | 01620 136C200 400C250 400C850 |
| 1965 | 89A | | GEOS A | 01726 136C830 162C 324C 972C |
| 1965 | 93A | | EXPLORER 30 | 01738 136.530 |
| 1965 | 98A | | ALOUETTE B | 01804 136C080 136C590 136C980 |
| 1965 | 98B | | DME-A | 01806 136C380 |
| 1965 | 101A | | FR-1 | 01814 136C350 136.800 |
| 1965 | 109A | | ESSA-1 | 01864 150C 400C |
| 1966 | 08A | | ESSA-2 | 01982 136C230 136C920 |
| 1966 | 16A | | | 02091 136C770 137C700 |
| 1966 | 24A | | OAO-1 | 02119 150C 400C |
| 1966 | 31A | | NIMBUS-2 | 02142 136.440; 136C260; 400C550 |
| 1966 | 40A | | | 02173 136.500; 136C950; 137C200; 1707C5 |
| 1966 | 41A | Explorer 32 | | 150C 400C |
| 1966 | 44A | OGO-3 | 02183 136C320; 136C560 | |
| 1966 | 49A | EGRS VI | 02195 136C200; 400C350; 400C850; 136C200 | |
| 1966 | 51B | ERS-16 | 02205 136.800 | |
| 1966 | 51C | Explorer 33 | 02202 136S440 | |
| 1966 | 58A | EGRS VII | 02258 136.020 | |
| 1966 | 77B | ERS-15 | 02411 136.800 | |
| 1966 | 77C | ESSA-3 | 02412 136S440 | |
| 1966 | 87A | EGRS VIII | 02435 136C770; 235C | |
| 1966 | 89B | INTEL SAT 2 | 02520 136.840 | |
| 1966 | 96A | | 02514 136C440; 136C980 | |

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington, D. C. 20006

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December 30, 1966

BULLETIN

DAY NUMBERS FOR RECORDING CHRONOLOGICAL DATA

IMPORTANT SAVINGS IN DATA PROCESSING costs can be realized when chronological information is recorded in terms of day numbers in a continuous chronological era, instead of in calendar months, days, and years. Until recently, the only regular users of day numbers were astronomers and scholars. More recently, the application of solid-state electronic computers with magnetic core storage to clerical tasks, such as payroll accounting and keeping insurance records, has been rocketing day numbers from academic obscurity to standard commercial practice.

DAY NUMBERS IN A CHRONOLOGICAL ERA differ from days of the month or days of the year in that the enumeration is not cyclical. There is only one epoch from which time is measured in the era. In a given chronological era there can be one, and only one, day number for a given day.

THE MODIFIED JULIAN EPOCH introduced during the International Geophysical Year began at 00 hours, Universal Time, November 17, 1858 A.D. The Modified Julian Day number, therefore, denotes the number of days since the above epoch that has elapsed at 00 hours U.T. on the day designated. The particular epoch was chosen to simplify conversion from Julian Day numbers employed in classical astronomy.*

THE MODIFIED JULIAN DATE (MJD) corresponding to any instant is but a simple extension of the above concept. MJD is the Modified Julian Day number, followed by the fraction of a day elapsed since 00 hours U.T. Conversion from Modified Julian Date (MJD) to Gregorian calendar date and back can be accomplished by simple computer algorithms or tables, as described below.

CORE STORAGE REDUCTIONS realized in using Modified Julian Dates (MJD) are substantial. According to W. P. Overbeck, Director of the Savannah River Laboratories**:

"The gain that we make in using MJD in our records, rather than calendar dates, is in reducing storage requirements by a factor of three for each date. This is important to us. . . because we have the type of program in which all records are placed in magnetic core storage. This is a problem when you are dealing with records for several thousand people."

*At 00 hours U.T. November 17, 1858, A.D., the Julian Date (JD) was 2,400,000.5.

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UNIVERSAL TIME (U.T.), strictly speaking, is a measure of the earth's rotation with respect to the mean sun. It describes the polar angle, TNL, measured from the geocentric projection of the earth's mean shadow center (T), around the North Pole (N), to the geocentric projection of the Greenwich Observatory (L) at a particular instant. If we identify the direction of (T) at November 17.0, 1858 U.T. by the symbol, J, we can describe the epoch of any event by the magnitude of the angle, JNL, at such epoch. The preferred way of doing so is in turns and decimal fractions. By definition, then, the angular measure, JNL, is identical to Modified Julian Date (MJD). The very small and somewhat uncertain secular variations in the length of mean solar days are unimportant for chronological purposes.

COMPUTER SUBROUTINES, JAYDAY & CALDAY, are given below. Subroutine JAYDAY gives the value of JNL (MJD) corresponding to Gregorian Calendar month, day, and year of the 20th and 21st centuries. Subroutine CALDAY gives, for the same period, Gregorian Calendar month, day and year, corresponding to JNL (MJD).

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SUBROUTINE JAYDAY(NM,ND,NY,JNL)
C      GIVES JNL = DAYS SINCE NOV. 17.0 UT 1858 CORRESPONDING TO GREGORIAN CALENDAR MONTH, DAY & YEAR.
C      IF(NY.LT.1901)GO TO 10
C      IF(NY.LT.2100)GO TO 11
10  JNL=0
    GO TO 14
11  MM=NM
    MY=NY-1900
    IF(MM.GT.2)GO TO 12
    MM=MM+9
    MY=MY-1
    GO TO 13
12  MM=MM-3
13  JNL= 15078+(1461*MY)/4+(153*MM+2)/5+ND
14  RETURN
    END
```

```
SUBROUTINE CALDAY(NM,ND,NY,JNL)
C      GIVES GREGORIAN CALENDAR MONTH, DAY & YEAR CORRESPONDING TO JNL = DAYS SINCE NOV. 17.0 UT 1858
C      IF(JNL.LT.15384)GO TO 10
C      IF(JNL.LT.88067)GO TO 11
10  NM=0
    ND=0
    NY=0
    GO TO 13
11  NSEQ=JNL-15078
    NY=(4*NSEQ-1)/1461
    ND=(4*NSEQ+3-1461*NY)/4
    NM=(5*ND-3)/153
    ND=(5*ND+2-153*NM)/5
    IF(NM.GE.10)GO TO 12
    NM=NM+3
    NY=NY+1900
    GO TO 13
12  NM=NM-9
    NY=NY+1901
13  RETURN
    END
```

